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Experiment Station Work, XX.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.
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EXPERIMENT STATION WORK.

Edited by W. H. BEAL and the Staff of the Experiment Station Record.

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ILLUSTRATIONS.

EXPERIMENT STATION WORK—XX.[a]

THE VALUE OF MUCK OR PEAT.

Beds of meadow muck or peat are of frequent occurrence throughout the country, and in many localities the material is utilized more or less as a fertilizer, though not to as great an extent as before the introduction of the more concentrated commercial fertilizers. In order to use muck with economy, it is necessary to know something of its value as compared with other fertilizing materials commonly used. F. W. Morse, in a bulletin of the New Hampshire Station, makes such a comparison of muck and barnyard manure. For this purpose were taken the average composition of 19 samples of manure from different farms, as follows: Water, 70.27 per cent; nitrogen, 0.387 per cent; phosphoric acid, 0.249 per cent, and potash, 0.388 per cent; and of 29 samples of muck, as follows: Water, 77.36 per cent; nitrogen, 0.452 per cent. According to these analyses a cord (3 tons) of manure contains 23¼ pounds of nitrogen, 15 pounds of phosphoric acid, and 23¼ pounds of potash; the same quantity of muck, 27 pounds of nitrogen. On the basis of these figures it is estimated that as regards fertilizing constituents 1 cord (3 tons) of manure is equivalent to 3½ cords of muck. It can readily be seen from these figures that the value of muck as a fertilizer is too low to pay for any extended handling or transportation. It should also be borne in mind that mucks vary widely in character, ranging from nearly pure peat to clay loam blackened by humus, and that the use of only the richest of them is likely in any case to prove economical.

[a] This is the twentieth number of a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint our farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should, for the most part, be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. True, Director, Office of Experiment Stations.

IMPROVED CULTURE OF POTATOES.

In a previous bulletin of this series[a] the conclusions from several years' experiments in the culture of potatoes by the New York Cornell Station, cooperating with farmers in different parts of the State, were summarized. These experiments have been continued along the same lines during another year, and have given additional results of practical value. These results emphasize the importance of maintaining a sufficient supply of humus in the soil to conserve moisture. "On a soil well supplied with humus the moisture may be conserved even through a severe drought, and a fair crop of potatoes produced." The great importance of thorough tillage has been very clearly brought out in these experiments, but it has also been shown that "intensive tillage alone is not sufficient to produce a large yield of potatoes. * * * Intensive tillage may be overdone. During a drought only so much tillage is necessary as shall keep the surface mulch loose and thoroughly dry. The drier the surface layer of soil the more slowly will moisture be absorbed by it from the layers of subsurface soil." Harrowing potato land before the plants appear above ground is considered a wise practice. The use of Bordeaux mixture in nearly every case resulted in an increased yield, even when blight was not prevalent, and thorough spraying with this material is therefore recommended as a general practice. Pruning potato vines to one main stem was not beneficial.

Potato machinery, while not yet perfected, has reached such a degree of perfection that where potatoes are grown upon any considerable area special potato machinery should be provided. Implements should be purchased which are found adapted to the local conditions.

There is no royal road to success with potatoes. Methods of procedure which are applicable during one season must be modified to meet the requirements of another season; treatment of one soil might be radically wrong when applied to another soil. Success will be attained only by thorough familiarity with the plant and its habits of growth, and then conditions must be made to meet as completely as possible the requirements of the plant.

THE FARMER'S VEGETABLE GARDEN.

As pointed out by J. W. Lloyd in a recent bulletin of the Illinois Station, the purpose of the farm garden is to supply the farmer's family with a succession of vegetables throughout the season. It should add diversity to his table and be primarily of use rather than profit. Earliness, productiveness, and shipping quality, which are so important in the case of the market gardener, are of less importance with the farmer than suitability to his personal tastes. The farmer should grow the vegetables he likes and should provide these in abundance.

[a] U. S. Dept. Agr., Farmers' Bul. 92 (Experiment Station Work, IX), p. 9.

The garden should be located near the house. "To be at their best, most vegetables should be used very soon after they are gathered. The garden will be appreciated most if it is not far from the kitchen, not only because the vegetables may be used fresher, but also because the products of the garden will enter more largely into the daily bill of fare, if they are within easy reach."

"In order to secure data regarding the amount of labor involved in the care of a garden and the amount of produce it would yield, a 'farmer's garden' was planted upon the grounds of the horticultural department of the University of Illinois last spring, and was managed with a view to furnishing a continuous supply of vegetables throughout the season." The garden was planted in long, wide rows, so that most of the cultivation could be done with a horse. On the farm there is plenty of room, and economy of time is of more importance in the case of the garden than economy of land. A succession of the same vegetable throughout the season was secured by planting early, medium, and late varieties, or by planting the same variety at different times. If different varieties are planted there will be a greater expense for seed, while if only one or two varieties are used more plantings are necessary. A combination of these two methods was found most satisfactory. The following is the bill for the plants and seed used in the experiment:

Cost of plants and seed used in a "farmer's garden."

100 one-year-old asparagus roots, Barr Mammoth	$0.60
1 packet rhubarb seed, Myatt Victoria	.05
30 horse-radish sets	.10
1 pint onion sets, Egyptian or Perennial Tree	.15
1 quart onion sets, Yellow Bottom	.20
1 pint beans, Stringless Green Pod	.15
1 pint beans, Saddleback Wax	.15
1 pint beans, Henderson Bush Lima	.15
1 ounce beets, Crosby Egyptian	.10
1 ounce beets, Long Smooth Blood	.05
1 packet cabbage, Select Jersey Wakefield	.10
1 packet cabbage, All Head Early	.10
1 packet cabbage, Autumn King	.05
1 packet cauliflower, Vaughan Snowball	.25
1 packet carrot, Early Scarlet Horn	.05
1 packet carrot, Select Danvers	.10
1 packet celery, Giant Pascal	.05
1 packet cress, Curled Garden	.05
½ pint sweet corn, Mammoth White Cory	.06
½ pint sweet corn, Chicago market	.06
½ pint sweet corn, Stowell Evergreen	.06
½ pint sweet corn, Country Gentleman	.06
1 ounce cucumber, The Emerald	.10
1 packet lettuce, Improved Hanson	.05
1 ounce muskmelon, Emerald Gem	.10

1 ounce muskmelon, Champion Market	$0.10
1 ounce watermelon, Cole Early	.10
1 ounce watermelon, McIver Sugar	.15
1 ounce onion, Australian Brown	.20
1 ounce onion, Extra Early Flat Red	.10
1 ounce parsnip, Improved Guernsey	.10
1 packet parsley, Champion Moss Curled	.05
1 quart peas, Nott Excelsior	.25
1 quart peas, Hosford Market Garden	.25
1 quart peas, Improved Stratagem	.25
1 packet pepper, Ruby King	.05
1 ounce radish, Brightest Long Scarlet	.10
1 ounce radish, Earliest White	.15
1 ounce radish, Cincinnati Market	.10
1 ounce radish, New White Chinese (winter)	.10
1 ounce spinach, Long Standing	.05
1 packet salsify, Sandwich Island Mammoth	.05
1 packet squash, Summer Crookneck	.05
2 ounces squash, Chicago Warted Hubbard	.15
1 packet tomato, Stone	.10
1 ounce turnip, Purple Top Strap Leaf	.06
Total	5.45

"No seed potatoes were purchased, because there were plenty in the cellar available for the purpose. The farmer should usually save his own seed potatoes and perhaps the seed of a few other vegetables, but in the case of most of the garden crops it is cheaper to buy the seed than to raise, harvest, cure, and clean it. And, furthermore, better results can usually be secured from seed grown by men who make a business of seed growing than from home-grown stock."

The garden was 280 feet long and 77 feet wide. It was manured with 20 loads of well-rotted barnyard manure, plowed early in the spring, and well worked down. The rows were made 3 feet apart. The accompanying diagram shows the arrangement of the garden (fig. 1).

The space occupied by the early maturing vegetables was replanted with later crops. The early peas and potatoes were followed by ½ row celery, 1½ rows turnips, ½ row winter radishes, ¼ row of spinach, and ¼ row lettuce. String beans followed early string beans on the same land. The crops were harvested when needed by those in the kitchen, hence no account was taken of this work. The succession of vegetables secured and the period during which each crop was harvested is brought out in the accompanying diagram (fig. 2).

Cucumber beetles were controlled by spraying with Bordeaux mixture and cabbage worms by spraying with white hellebore.

The garden was cultivated, hoed, and hand weeded whenever this was necessary to keep it free from weeds and in fine tilth. This

required 27½ hours' team work (with 2 horses), 11½ hours' work with one horse, and 124½ hours hand labor. The team work was valued at $3 per day; horse work, $2 per day, and hand labor $1.25 per day. At these rates the total cost for labor was $26.11 for the season. Adding to this $5.45 for seed and 50 cents for insecticides brings up the total cost to $32.06.

"In return for this expenditure the garden furnished a continuous supply of fresh vegetables throughout the growing season, with enough sweet corn for drying; tomatoes for canning; cucumbers, peppers, cabbage, string beans, and green tomatoes for pickles; besides onions, beets, carrots, parsnips, salsify, winter radishes, cabbage, and celery for winter use; and parsnips, salsify, and horse-radish left in the ground for use in the spring." Putting a low estimate on the value of the crop secured "these vegetables could not ordinarily have been bought at retail for less than $83.84. This leaves a balance of $51.78 in favor of the garden. What other half acre on the farm would pay as well," or, we may add, would contribute more to the comfort, happiness, and well-being of the farmer and his family?

For more complete information regarding the cultivation and care of the more common vegetables the reader is referred to Farmers' Bulletin No. 94, of this Department.

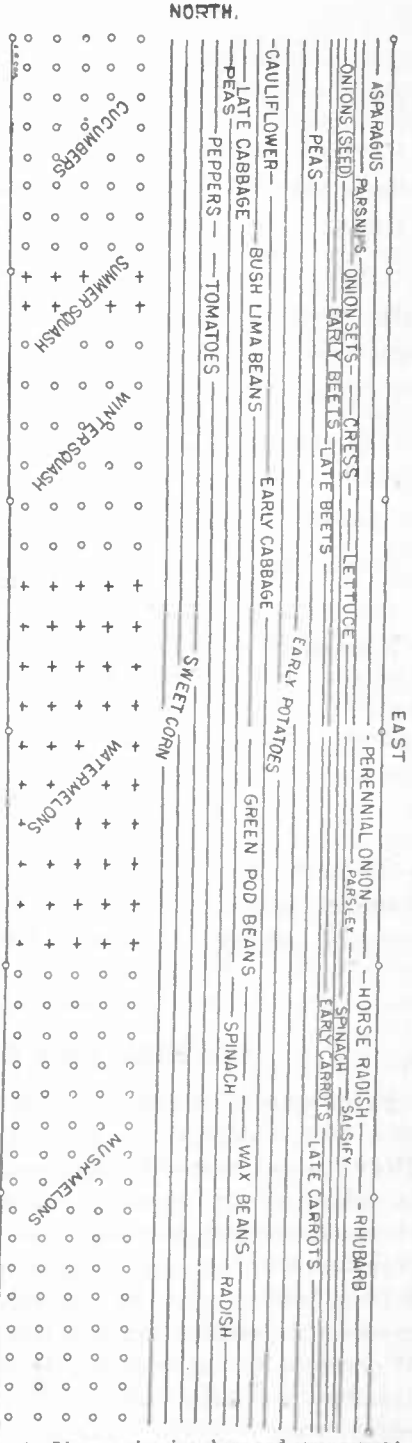

FIG. 1.—Diagram showing shape and arrangement of garden.

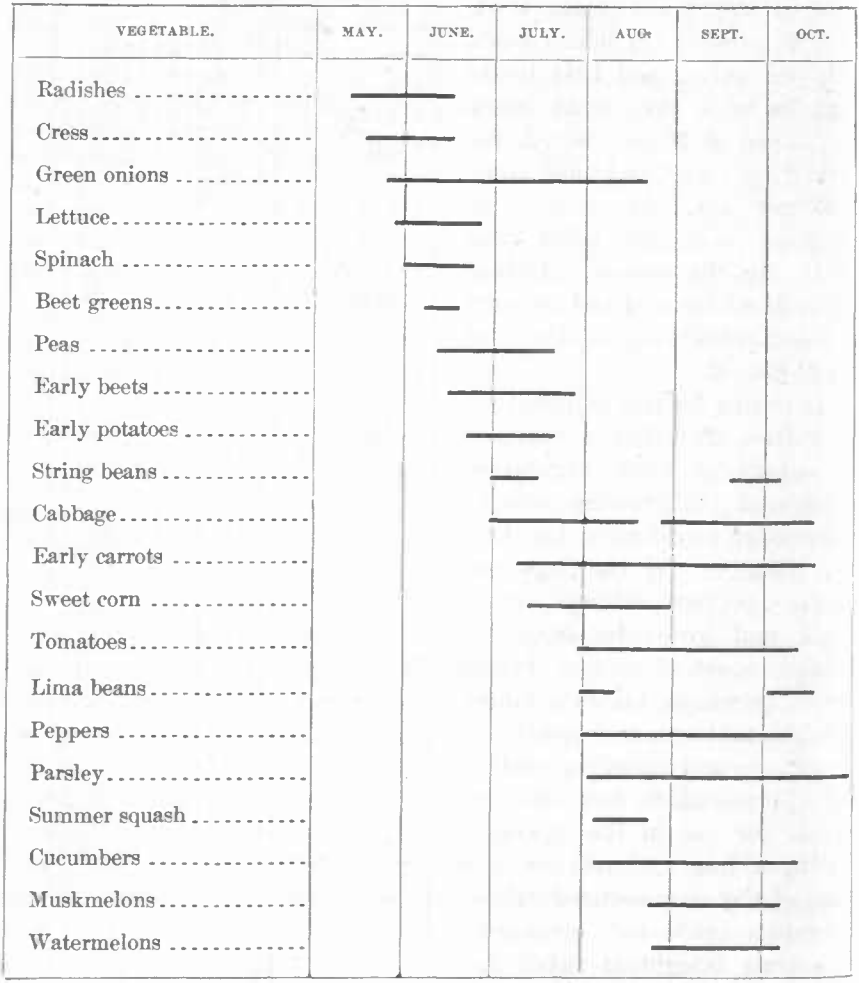

FIG. 2.—Diagram showing succession of vegetables.

THE SHRINKAGE OF FARM PRODUCTS.

Farm products stored after harvest are usually subject to variation in weight, which generally manifests itself in a loss, or shrinkage. The principal factors bearing upon the extent of this variation are the moisture conditions of the atmosphere, the degree of maturity at which the crop was harvested, and the method of storing. The question of shrinkage is always important to the farmer because it has a direct bearing upon the marketing of his products and the financial results. An estimate on how much may be realized from a quantity of grain or hay after storing for a certain time always necessitates a consideration of the shrinkage, for otherwise losses may result where profits were expected. Storing farm products, however, does not always entail a decrease in weight, but on the contrary sometimes results in a marked increase. Investigations on this subject have been

made at different experiment stations, and in a number of cases valuable observations in this line have been reported from other sources. The Michigan Experiment Station has recently published in a bulletin prepared by C. D. Smith the results obtained there and elsewhere, and these results are here briefly summarized.

Wheat.—The reported observations on wheat at the Michigan Station included studies on the variation in weight during storage and on the relation of the degree of ripeness to the weight of the grain. As early as 1879, Dr. R. C. Kedzie showed that wheat when allowed to become overripe, or dead ripe, as it is generally called, weighs slightly less than when harvested at the period of complete ripeness. It was also found that the amount and quality of the flour, as well as the germinating power of the grain, are reduced when the crop is allowed to stand after complete ripeness has been reached. The greatest loss, however, due to overripeness is caused by the shelling of the grain. Certain varieties of wheat have a lesser tendency to shell than others, and by giving these the preference and harvesting at the proper stage of maturity, loss from this source can be reduced to a minimum. In 1898 the shrinkage of White Clawson, a soft, white wheat, and Buda-Pesth, a hard, red variety, was determined. At the time of thrashing the grain was dry and in good condition, and after having been stored for 322 days, the White Clawson had lost less than a half of 1 per cent, and the Buda-Pesth less than one-tenth of 1 per cent.

The loss of weight during storage was observed in an elevator in Michigan, where 1,500 bushels of wheat in a hard and dry condition were stored immediately after thrashing. After 10 days a shrinkage of a little over 30 bushels, or a loss of about 2 per cent, had occurred. On another occasion 900 bushels put into this same elevator, while still slightly damp, lost 3¾ per cent in weight during 4 months. This loss represented a shrinkage of 30 bushels. These facts led to the conclusion that the variation in weight of well-cured wheat in Michigan does not amount to more than 5 per cent.

In laboratory experiments in this line, conducted at the New York State Station, small quantities of wheat were placed in netting bags, which were suspended from the ceiling of the laboratory. On July 18, when the grain was thrashed, it contained 27.02 per cent of water. The lowest water content while the samples were exposed to the natural air of the room was reached August 24, when it amounted to 6.4 per cent. On November 22, the room having then been heated by steam since October 12, only 2.96 per cent of moisture was present. At the same station, on various dates from September 22 to November 12, inclusive, samples were taken from the interior of a mass of several hundred bushels of wheat and the moisture content determined. It was found to vary from 11.96 per cent to 16.57 per cent. These results show how fast wheat loses its moisture and how extensive the shrinkage in weight becomes when it is subjected to dry air. Hilgard

found that air-dry grain of oats, barley, and wheat, placed into an absolutely dry atmosphere for 18 days, lost in weight 9.3, 7.8, and 6.2 per cent, respectively. The loss at first was very rapid, but it became slower and slower toward the end of the test.

On the other hand a number of experiments are on record which show the moisture-absorbing capacity of wheat and other grains. The results obtained by Hilgard are perhaps the most striking. He subjected dried grains of different cereals to an atmosphere as nearly saturated as it was possible to make it, the temperature being kept at 64.4° F. Due to the absorption of moisture, oats and barley gained in weight 19.8 and 20.4 per cent respectively in 18 days, and wheat gained 18.8 per cent in 14 days. Absorption progressed very rapidly at first, nearly one-half of the total increase in weight taking place during the first 24 hours. In another experiment by this same investigator, perfectly dry grain, dried artificially, was exposed to a saturated atmosphere at a temperature of 64.4° F. for 18 days, with the result that wheat gained 25 per cent in weight, barley 28.2 per cent, and oats 29.1 per cent. In a third experiment Hilgard kept wheat in an atmosphere prepared to be about as dry as the air at harvest time in the interior valleys of California. The results he obtained led to the belief that "wheat cured there in the field at harvest time becomes nearly as dry as it would in an absolutely dry air, and on transporting to a temperate climate, may possibly increase 25 per cent, while a gain of 5 to 15 per cent may be looked for with almost absolute certainty." The Utah Experiment Station has observed that in the dry climate of that State wheat gained slightly in weight during winter storage. Wheat flour and the coarser by-products of the flouring mills show a rise and fall in weight similar to whole wheat as the moisture content of the air changes.

Corn.—Of the various crops, corn is perhaps the one in which shrinkage during storing is the most apparent, owing to the moisture content of the ears at harvest time. This is the case even in the drier regions of the West and Northwest, where, in addition to the climatic advantages, the ears are generally husked from the standing stalks. Where the corn is put up for fodder, the ears continue to ripen in the shock, but do not dry out as well as if allowed to mature on the stalk. Frequently greater care needs to be exercised in storing corn than in storing other grains. During the time that corn is stored in the crib the shrinkage is greatest. In order that the drying process may go on freely, and the corn be prevented from heating or becoming moldy, the cribs are built so that the air can readily circulate through the mass. In the principal corn-growing sections of the West the cribs are generally built 8 feet wide, and sometimes even 10 feet, but in moister regions, as in some of the Eastern States, they are generally not more than 5 to 7 feet wide. After drying in the crib for a certain time,

corn shells with greater ease, and the shelled corn can be stored in bins without danger of spoiling.

At the Iowa Station, in 1898, 7,000 pounds of corn were husked and stored in a crib on October 19. The crib was built upon the platform of a pair of scales, so that weighings could be made at any time without moving the corn or destroying the normal conditions of storing. The weights taken weekly during an entire year show some variations due to the weather. The shrinkage during the year was 9 per cent of the original weight for the first three months, 5¼ per cent for the second, 3¼ per cent for the third, and 2⅝ per cent for the last three months. The loss for the entire period amounted to 1,430 pounds, or a little more than 20 per cent. In this case a bushel of corn weighing 80 pounds when stored, weighed 64 pounds at the end of the year; or if calculated to weigh 75 pounds when put into the crib, weighed 60 pounds after storing for one year. In a similar experiment the following year the total loss in weight for the entire period was 635 pounds, or a shrinkage of 9⅜ per cent. At the close of this second experiment the kernels contained 12.14 per cent of water, and the cob 25.82 per cent. The corn used in this test was in a much drier condition than the corn used the preceding year, and the season had a much larger rainfall. These conditions largely account for the smaller shrinkage.

The results of observations along this same line by private parties are also on record. In central Illinois 16,155 bushels were husked and placed in the crib from October 22 to December 17, 1894. The following July a shrinkage of 1,258 bushels was found to have occurrred, or a loss of about 7¾ per cent. The season during which this corn was stored was quite dry.

At the Michigan Station 16,767 pounds of corn, quite damp and heavy, owing to the condition of the weather, were put into a crib on October 3 and 5. On February 13 following the loss in weight amounted to 5,725 pounds, or a little over 30 per cent. This result is extreme, but it shows clearly to what extent the condition of the weather can affect the shrinkage. On another occasion 3,310 pounds of ear corn in a fairly dry condition were hauled from the field October 21. The weather at the time was damp. The corn was left in the sack until January 23, when it had lost 359 pounds, or nearly 11 per cent.

The average results of a series of experiments conducted at Houghton farm by Dr. Manly Miles showed that corn in the ear shrank 15.28 per cent during the winter, the shelled corn 7.45 per cent, and the cobs 36.78 per cent. Taking these results into consideration, it can readily be seen that it is frequently best to sell the corn in the fall.

There are two other methods of storing corn which have received attention by experimenters; the one is storing the whole plant as fodder, and the other as silage in the silo. Observations recorded by the Connecticut State Experiment Station show that 5 tons of well-

cured fodder stored loosely in a barn during a damp and warm winter absorbed enough moisture from the air from November 11 to February 8 to weigh 8 tons. The average loss for 4 silos at the Michigan Station was 8.32 per cent of the weight of the corn as it was put into the silo. At the Wisconsin Station the loss in gross weight which took place between putting the corn into the silo in the fall and taking it out in the winter varied in seven cases from 10.90 per cent to 20.52 per cent, with an average of 14.48 per cent. The decrease in weight of corn in the silo is not entirely due to a disappearance of water from the plant tissues, but in part to the decomposition of organic matter and the formation and escape of gases.

Oats.—The experiments reported with oats indicate that the grain, after having passed through the sweating process, shrinks but little. The highest shrinkage observed in the tests recorded in the bulletin was 3.4 per cent during a period of about 7 months.

Hay.—The variations in weight of hay are perhaps more marked than in most farm products. A considerable difference in shrinkage occurs between hay cured in dry weather and hay cured when the atmosphere is more or less moist. For this reason the shrinkage in hay in a dry climate is usually smaller than in the more humid regions. At the Kansas Station small quantities of thirteen different kinds of hay buried in the mow from 4 to 6 months shrunk 4.5 per cent on an average, ranging from a 14 per cent loss to a 3 per cent gain. Five tons of very dry timothy hay stored in a mow for 6 months at the Michigan Station lost nearly 7 per cent, and in another test 5,600 pounds of the same kind of hay in good condition placed in the mow July 6 had lost 776 pounds, or 13.8 per cent, by February 18 following. Practical men estimate that hay put in the mow when in good condition usually shrinks about 20 per cent by the time it is baled. The Utah Station has reported a loss of a little over 15 per cent in a ton of timothy hay after it had been kept in the barn for 9 months. A stack of timothy hay containing a little over 2 tons and built in the open had gained a little over 1 per cent during the same time. The results with clover hay at the same station show a loss of 3.75 per cent during 9 months when kept in the barn and a gain of 10 per cent for the same period when stacked out of doors. At the Missouri Station timothy hay in the stack lost about 12.5 per cent by spring, and when stored in the mow about 7 per cent. A stack of second-growth clover put up at this same station in July had shrunk about 30 per cent in weight by the following March.

The results of experiments conducted by different stations show that the degree of maturity at which hay is cut influences very largely the shrinkage during curing. At the Pennsylvania Station early-cut hay lost on an average 29 per cent in weight, while late-cut hay lost only 21.5 per cent. Timothy cut when just beginning to head lost 75 per cent of water in curing; when cut at the beginning of the blos-

soming period, 66 per cent; and cut a little later, or about the usual time, 57 per cent. The Michigan Station found a shrinkage of about 60 per cent in curing clover. At the New York State Station, meadow fescue mixed with a little red clover lost in one lot 62.68 per cent and in another 58.25 per cent, during curing. The moisture retained in cured fodder varies with different kinds. Atwater states that for New England timothy hay retains on an average 12 per cent of moisture, clover hay 14 per cent, and corn fodder 25 per cent.

Grass seed.—At the Michigan Station 4,000 pounds of Hungarian grass seed put into a tight bin November 4, 1896, weighed but 3,904 pounds July 10, 1898, which represents a loss of 2.8 per cent.

TRANSPLANTING AND MANURING MUSKMELONS.

E. Walker has recently reported, in a bulletin from the Arkansas Station, some interesting experiments in transplanting and manuring muskmelons. In growing muskmelons for market, earliness is considered of prime importance with at least part of the crop. One method of securing extra earliness is to start the plants 2 or 3 weeks before the usual time for outdoor planting in pots or some other similar vessels in a mild hotbed, and then transplant to the open field.

In the experiments at the Arkansas Station the melons were started in flowerpots April 18 and set in the open field May 13. Seed was sown in the open field on the latter date. Thirty-four varieties of melons were used in the test and a part of the hills manured with well-rotted barnyard manure. The transplanted melons ripened their first fruits on an average about 21 days earlier than the field-grown melons. The manured melons also matured fruit in every instance earlier than the unmanured, the average increased earliness for 23 varieties which were comparable being 14 days.

A special test was made of the manner of using thoroughly mixed well-rotted barnyard manure in muskmelon hills. The manure was applied (1) in a shallow circular trench, leaving the worked center free from manure and 18 inches across; (2) to the surface and thoroughly worked into the soil; and (3) in the bottom of the hill, the manure reaching to within 4 inches of the surface and covered with 4 or 5 inches of soil. Other hills were spaded, but received no manure. The table below shows the results secured in the different instances:

Effect of different methods of manuring muskmelons.

Method of manuring.	Time to maturity.	Average number of fruits per hill.	Average weight of fruits.
	Days.		*Ounces.*
Manure in circular trench	95.35	7.92	32.97
Manure well worked into the soil	85.60	8.22	29.63
Manure placed under the hill	89.62	7.27	30.00
Unmanured	103.11	5.33	32.54

The table shows that the earliest melons and the largest number per hill were obtained when the manure was applied to the surface of the ground and well worked into the soil. This method of manuring is also considered to be the most feasible for commercial growing, since instead of planting in hills, continuously manured furrows 8 to 10 feet apart in well-prepared land can be used and the manure thoroughly mixed with the soil by passing backward and forward several times in the furrow with a bull tongue or single shovel plow. The fertilized furrows should finally be thrown into a low, broad ridge with a light plow and thoroughly dragged and harrowed. The seed should then be planted about 18 inches apart along the furrows thus made. The plan of placing the manure in a circular trench around each hill or of putting it in the bottom of the hill is considered too expensive for practical purposes, except on a limited scale.

These experiments seem to show that under the conditions existing in Arkansas the earliness of muskmelons can be hastened 2 to 3 weeks by starting the plants in hotbeds and transplanting, and that applying well-rotted manure to the surface and working it into the soil is more economical and gives as satisfactory results as the more expensive methods of putting it under the hill or in trenches around the hills.

SOILS FOR STRAWBERRIES.

The New Jersey State Experiment Station has made a fruit survey of that State, and reports that for the northern section of the State 65 growers preferred a sandy soil for strawberries, 18 a clay loam, and 3 slaty soils. In the central section, 57 growers preferred sandy soil and 23 clay loams. In the southern section of the State, where the great majority of strawberry growers are located, 625 preferred sandy loam and 349 clay loam soils. From the southern section statistics were also obtained as to the yields on the different soils. In 1893 the average yield secured by 290 growers on clay loam soils was 2,909 quarts per acre; on sandy loam soils the same year 240 growers secured an average of 2,508 quarts per acre—401 quarts per acre in favor of the heavier soils. The following year the differences were still more marked. On a clay loam the average yield of 306 growers was 3,223 quarts, while on sandy soil 387 growers obtained an average of 2,359 quarts per acre—a gain of 864 quarts for clay soils.

On the whole, it would seem that wherever yield is of special importance, clay loams are likely to make the most satisfactory strawberry beds. For early crops, however, it is advisable to select a quick, sandy loam, southern exposure, and early varieties; for late crops, a northern exposure, clay soil, and late varieties.

FERTILIZER REQUIREMENTS OF STRAWBERRIES.

On the basis of the results of analyses reported by the Oregon Station, a crop of 6,000 pounds of fresh fruit, which is considered a fair yield per acre, will remove from the soil 8.4 pounds of nitrogen, 10 pounds of potash, and 3.5 pounds of phosphoric acid. It is thus seen that the strawberry is not at all an exhausting crop on the land, yet in practice it is found that it requires a far more liberal manuring than most fruit crops. The main reason for this is its comparatively short growing period in the early part of the year. With favorable weather conditions after the plants start in the spring they grow fast, soon blossom, and rapidly develop their fruit, thus requiring in a short time relatively large amounts of immediately available nitrogen, phosphoric acid, and potash, and these elements must be in the soil in abundance to meet this demand if the best results are to be obtained.

Well-rotted barnyard manure is the fertilizer most generally used and recommended by the experiment stations for strawberries. It should never be used fresh. If not well rotted, it is generally foul with weed seeds and fungus diseases, and conduces to a rank growth of vine and a fruit of poor shipping quality. To supplement the barnyard manure, which is often of poor quality, from 50 to 100 bushels per acre of unleached ashes are recommended.

In some localities the high cost of barnyard manure is an argument against its use, and where the soil can be supplied with humus from other sources as by turning under green manure crops, like clover and cowpeas, commercial fertilizers are profitably used. At the Maryland Station a carload of stable manure costing $31 was tried in comparison with commercial fertilizers costing but $7, with the advantage of growth of vines and early maturity of fruit decidedly in favor of the commercial mixture.

Where barnyard manure is not available, or its high cost makes its use unwise, ashes and ground bone may be used to supplement green manuring. The green crops should be plowed under in the fall, and the bone and ashes applied broadcast in the spring, and lightly harrowed in. This plan has given quite general satisfaction among strawberry growers.

In the use of commercial fertilizers for strawberries, H. J. Patterson, of the Maryland Station, has suggested two formulas which have proven popular among growers in different parts of the State. The first formula is as follows: Dissolved South Carolina rock, 1,000 pounds; fine-ground dried fish or tankage, 600 pounds; nitrate of soda, 100 pounds; and muriate of potash, 300 pounds. These should be mixed and worked into the row at the rate of 400 to 600 pounds per acre before the plants are set. The soluble phosphoric acid of the South Carolina rock, the nitrogen of the nitrate of soda, and the potash will be readily and immedi-

ately available to the plants, and will give them a good start. The fish will yield its nitrogen and phosphoric acid gradually, and, with the phosphoric acid of the South Carolina rock, and the potash from the muriate, will keep the necessary foods constantly at the disposal of the plants. For old beds, the following mixture, applied early in the spring by sowing along the rows close to the plants and working into the soil lightly with a hoe or cultivator, is suggested: Dissolved South Carolina rock, 1,100 pounds; dried blood, 200 pounds; nitrate of soda, 400 pounds; and sulphate of potash, 300 pounds. Mix, and apply at the rate of about 300 pounds per acre. This same mixture, it is stated, often gives good results, and aids in the formation of runners if applied in the fall to plants set in the spring that have not done well.

In Georgia the normal formula used at the station for strawberries is made up of 1,140 pounds of superphosphate, 540 pounds of nitrate of soda, and 320 pounds of muriate of potash, analyzing about 8 per cent phosphoric acid, 8 per cent of potash, and 4 per cent of nitrogen, and applied at the rate of 800 to 1,000 pounds per acre. This formula was compared in experimental work with 16 other mixtures and combinations. The first application of the fertilizers was made in the rows just previous to planting in the fall, after which the fertilizers were drilled in on each side of the rows in the spring. The best results were secured when 1,280 pounds of kainit, furnishing about the same number of pounds of potash, were substituted for the muriate in the normal formula. When cotton-seed meal was substituted for the nitrate of soda in the same formula, not nearly as good results were secured. Similar results with cotton-seed meal were also obtained in experiments at the Florida Station, where it also produced a fruit of poor shipping quality. It is suggested by the Georgia Station that possibly the increased value of the kainit over the muriate of potash was due in a measure to its insecticidal effects in the soil upon the white grub, cutworms, root lice, and other insects which affect strawberries. The insecticidal value, however, of kainit is a mooted question on which experimental evidence is about equally divided.

The New York Cornell Station recommends the following fertilizers for the strawberry:

Fertilizers for strawberries.

	Per cent.	Pounds for 1 acre.	Furnished by the given amounts (pounds) per acre of the following materials:
Nitrogen	3	25 to 50	(1) 150 to 300 pounds nitrate of soda; or (2) 125 to 250 pounds sulphate of ammonia; or (3) 250 to 500 pounds dried blood; or (4) 5,000 to 10,000 ponnds stable manure.
Available phosphoric acid	7	55 to 110	(1) 550 to 1,100 pounds bone meal; or (2) 375 to 750 pounds dissolved bone, etc.; or (3) 450 to 900 pounds dissolved rock.
Potash	9	70 to 140	(1) 140 to 280 pounds mnriate; or (2) 140 to 280 pounds sulphate; or (3) 550 to 1,100 pounds kainit; or (4) 1,400 to 2,800 pounds wood ashes.

The same station recently reported the results of a cooperative test of a large number of fertilizers for strawberries with growers. The fertilizers used were the sulphate and muriate of potash, dissolved rock phosphate, ashes, and nitrate of soda. These were used singly and combined, and in varying amounts. "The fertilizers were applied to young plantations in spring after the first tillage and before the plants bloomed, a year in advance of the recorded crop. The materials were scattered alongside the row, within a few inches of the plants, and were cultivated in." The soils upon which the tests were conducted varied from gravelly loam through meadow land to black muck.

Some contradictory data were secured on the different farms and plats, but on the whole there was considerable uniformity of results. The fertilized plats in 55 experiments yielded on an average 5,197 quarts per acre, or about 2,000 quarts above the average, thus showing the great value of manuring the strawberry bed. The potash and phosphatic fertilizers were much more effective than nitrogenous fertilizers, especially on lands well supplied with humus, like muck soils. The fruits grown with these fertilizers were better colored, better flavored, and firmer. The nitrogenous fertilizers, including heavy applications of barnyard manure, gave too much growth of vine and the fruit was softer and of inferior quality. It is suggested that in these experiments the good tillage given probably supplied sufficient nitrogen in most instances.

In late years the practice has been growing of top-dressing strawberries with nitrate of soda in the spring, and a number of experiments have been conducted by the stations along this line. At the New Jersey Station, on a sandy loam soil, which was well fertilized with potash and phosphoric acid, spring applications of 200 pounds of nitrate of soda per acre were made. The nitrate was ground fine and applied broadcast after the foliage was well started, but before any bloom appeared, care being taken to apply it when the leaves were dry. Plants thus treated showed a deeper color, a much stronger bloom, larger leaves, and a greater freedom from rust than plants which had received the same applications of phosphoric acid and potash, but no nitrate. The fruit yield was increased from 18 to 31 per cent, largely due to the increased size of the berries. Contrary to the usual belief, the ripening period of the fruit in these experiments was not delayed by the use of the nitrate.

In this connection it must be remembered that nitrate of soda, which furnishes immediately available food to the plant, will increase the growth of vine disproportionately unless mineral elements are also applied at the same time or already exist in sufficient quantity in the soil. Similarly it may be stated that where large quantities of barnyard manure have been used year after year, applications of phos-

phoric acid and potash will be found most effective. In Florida, where berries are shipped a thousand miles to market, the station advises that nitrate of soda be not used for at least three months before shipping begins, as it has a tendency to soften the fruit.

At the Ohio Experiment Station, a number of different fertilizers, including superphosphate, nitrate of soda, sulphate of potash, muriate of potash, common salt, barnyard manure, bone meal, and sulphate of ammonia, were used on alternate plats of strawberries to ascertain the effect of various fertilizers upon the quality of the fruit. So far as could be determined by analyses the various fertilizers had no effect in changing the composition of the fruit, but in two other respects there were decided differences. On the superphosphate plat the fruit ripened several days earlier than upon the nitrate of soda plat, and upon another plat where sulphate of ammonia was used the difference in the time of ripening was still more marked. Potash and superphosphate seemed to have no appreciable effect on the growth and color of the foliage, but the nitrate of soda, and especially the sulphate of ammonia, tended to produce a much stronger growth and a foliage of a darker green color than on the other plats. "It was also evident that while sulphate of ammonia and nitrate of soda promoted growth of the foliage, they decreased the quantity of fruit."

From a careful study of the anatomy of the strawberry plant, the Wisconsin Station is of the opinion that a liberal top-dressing with fine manure or a very fertile soil after the fruiting season is the most rational method of fertilizing the strawberry plantation. This dressing protects the crowns of the plants from excessive summer heat and furnishes the young roots with abundant nourishment throughout the growing season, developing strong plants which are able to store up in the short stems a good supply of reserve material for the first leaf growth the following spring.

PLUM CULTURE.

In a recent bulletin of the Vermont Station, F. A. Waugh states that while plums stand next in importance to apples as an orchard crop in that State, they are not cultivated as extensively as they ought to be. This remark applies also to many localities outside of Vermont, for in many cases the culture of plums has not only not extended, but has positively declined in recent years. Plums are not difficult to cultivate, and they are among the hardiest of our orchard fruits. Renewed interest in this fruit has been awakened by the introduction of choice Japanese and other foreign varieties and by a realization of the hardiness* and other valuable qualities of many of our native sorts. In the

*Professor Waugh states that "the Americana plum and the closely related members of the Nigra and Miner groups are hardier than any other known fruit trees in America."

long list of varieties now under cultivation some may be found suited to almost every condition of climate found in the United States and to every soil, from heavy clays to the lighter sands. The following summary of information relating to plum culture is based mainly on bulletins of the Kansas, Vermont, and Wisconsin stations:

Varieties.—These belong to several widely different classes: (1) Domesticas, the old-fashioned European plum, including among others such well-known varieties as the Green Gage, Lombard, Bradshaw, and Yellow Egg; (2) damsons, formerly so widely known and still highly prized for home use, although the fruit is considered of inferior quality; (3) Japanese varieties, including Abundance, Burbank, Red June, Chabot, Kerr, and many others, differing widely from varieties commonly grown in America, but "thrifty, sturdy growers, and early and prolific bearers, and hardy wherever the Baldwin apple can be successfully grown;" and (4) Americana, or native group, including numerous selected wild varieties, improved somewhat by cultivation, such as De Soto, Surprise, Wyant, and many others, which have been grown to some extent for the market, mainly in the Mississippi Valley. The native varieties are very hardy and adapted to a wide range of conditions, but are generally inferior in quality to the varieties of the other groups. This is due largely to the thickness of the skins and the harshness of the skins and seeds. These undesirable qualities may in time be eliminated by good culture and by plant breeding, and may to a large extent be overcome by proper treatment in cooking. There are also a large number of hybrid plums, combining the qualities of the above groups, but their relative merits have not yet been fully established.

"The majority of plums do not bear well, and most of them set no fruit at all unless two or three varieties are mixed together in the orchard. The reason for this is that the blossoms of most varieties do not pollinate (or fertilize) themselves. They must be pollinated from the blossoms of some other kind of plum. Almost any other kind of plum which blossoms at the same time will answer for the pollination of any given variety." This subject of pollination has been fully discussed in earlier bulletins of this series.[a]

Soil.—The Domesticas and the damsons prefer a heavy clay soil, while the Japanese varieties and some of the hybrids may be grown on light sandy soils. Taking all varieties into consideration, the best soil for plums is a loose, deep gravelly soil with an open subsoil such as is suited for apples or potatoes, although almost any soil may be used provided it is well drained.

Planting.—For setting in the orchard strong 1-year-old trees are considered satisfactory with most varieties, but with Domesticas and

[a] U. S. Dept. Agr., Farmers' Buls. 65 (Experiment Station Work—II), p. 17; 103 (Experiment Station Work—XI), p. 6.

damsons 2-year-old trees are probably best. Spring setting is generally recommended, although when the work is well done by one who knows how to plant the trees, fall planting is preferred. As a rule the trees should be set 15 feet apart each way with all varieties exeept Burbank, which should have 20 feet or more.

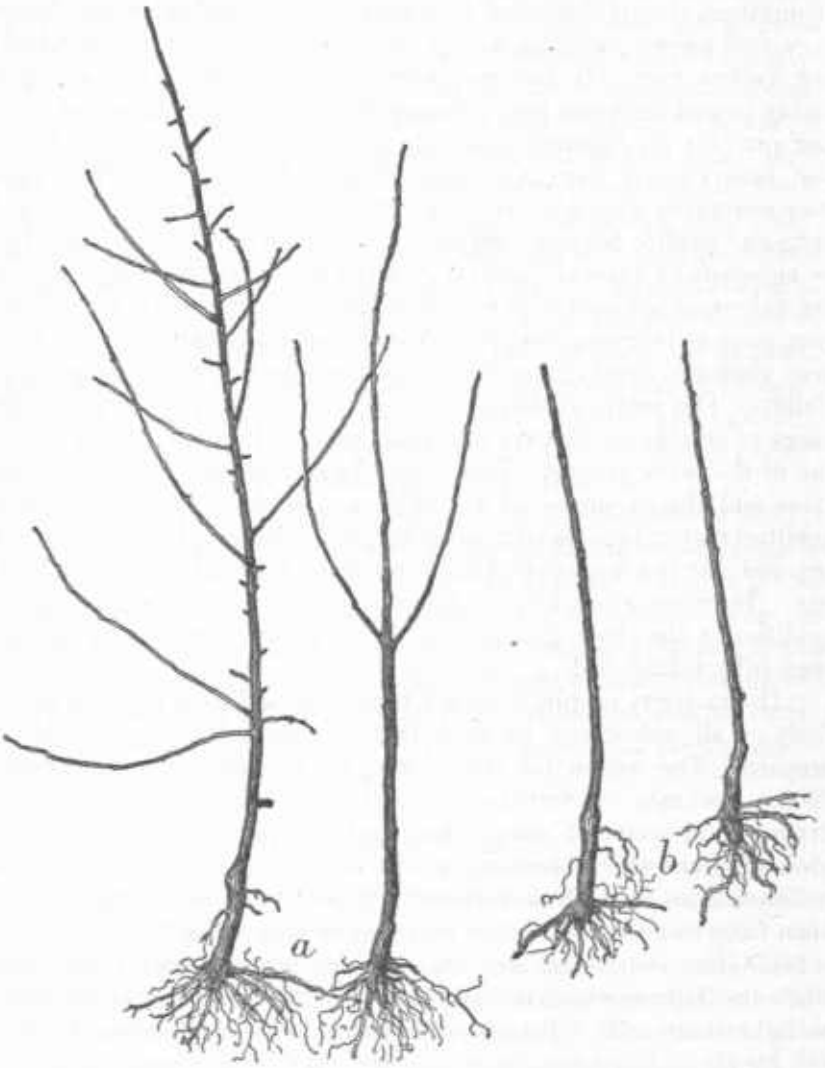

FIG. 3.—One-year-old plum trees: *a*, unpruned; *b*, pruned for planting.

Pruning.—The method of pruning the young trees when they are set in the orchard, recommended by Waugh, is shown in the accompanying illustration (fig. 3). The top is pruned to a straight whip and the whip cut back to 2 to 3 feet, depending on the variety and the strength of the young tree. The following summer a number of side branches

will be sent out from the sides of the straight stalk; from 4 to 6 of the most desirable of these which are well distributed around the trunk are allowed to grow and the remainder pinched off. In late August or early September the tops of these branches are cut off in order to stop growth and harden them up. Suckers are removed as soon as they appear. At the end of the first year in the orchard the tree will have an appearance similar to that in fig. 4.

At the opening of the second spring all the branches are cut back to a length of 6 to 18 inches, depending on the vigor of the tree—the weaker the tree the more closely it is shortened in. From 1 to 3 new branches, but preferably 2, are allowed to grow on each primary branch, and these are handled in the same manner as the primary branches were the preceding summer. Thus treated, the tree is usually in bearing condition at the end of the second year and should give a moderate crop of fruit the third year. According to E. S. Goff, of the Wisconsin Station, the trees of the American varieties seem to require more pruning than those of the European or Japanese varieties.

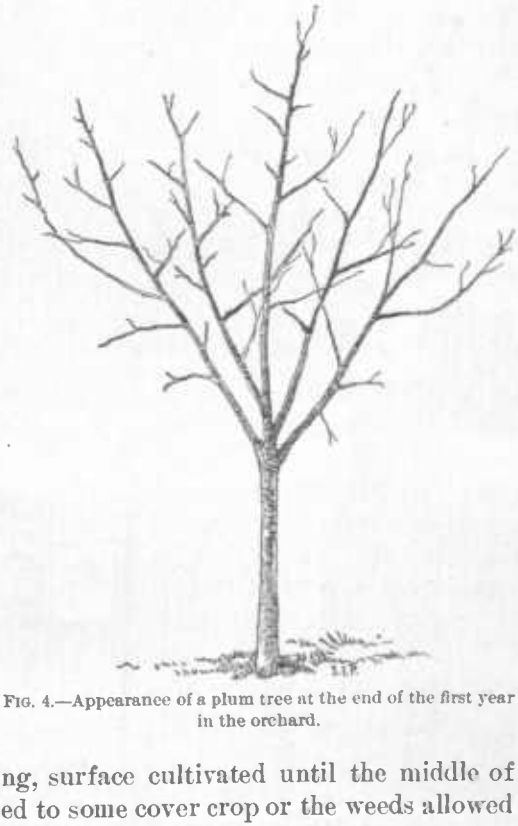

FIG. 4.—Appearance of a plum tree at the end of the first year in the orchard.

Cultivation, manuring, and mulching.—According to Waugh, the plum orchard should be plowed between the trees every spring, surface cultivated until the middle of the summer, and then seeded to some cover crop or the weeds allowed to grow. Goff has found mulching with straw, marsh hay, etc., preferable to cultivation, the mulched trees giving a superior quality and size of fruit. E. A. Popenoe, of the Kansas Station, states that his experience and observation warrant "the recommendation of clean culture for plums, keeping the ground shallowly cultivated or disked. The two-horse spring-tooth cultivator and a 5½-foot disk have been used while the trees were small, and a one-horse, five-toothed cultivator since the trees have grown too large for the two-horse tools. By the use of these tools the surface soil is kept loose and fine. Where exposed to winds, or so sloping as to be in danger of washing, sowing

oats or rye in August is a good preventive. Oats are preferable, as the rye is hard to kill in spring by shallow cultivation." A moderate amount of barnyard manure applied to the orchard every other year is recommended by Waugh, and wood ashes may be applied with advantage to soils deficient in lime.

Thinning.—Goff states that "in most varieties of native plums thinning is necessary to secure the finest fruit and to prevent deterioration of the size of the fruit from year to year, especially in the

FIG. 5.—Curculio catcher. The can below the canvas into which the insects fall is partly filled with kerosene.

Americana varieties. Thinning does not increase the total yield of plums, as has sometimes been claimed. On the contrary, heavy thinning reduces the total yield materially. Where the market does not discriminate in price between medium-sized and large plums, thinning will not pay unless the trees decidedly overbear. In this case it will pay for the benefit of the trees. While early thinning is to be preferred, late thinning is far better than none." This subject has been discussed in an earlier bulletin of this series.[a]

[a] U. S. Dept. Agr., Farmers' Bul. 73 (Experiment Station Work—IV), p. 16.

Diseases and insect enemies.—According to Waugh, black knot is best controlled in the orchard by its prompt removal with a pruning knife as soon as it is seen. The brown rot or ripe rot of the fruit, which comes on just as the fruit is ripening, is best controlled by heavily spraying the trees with a solution of copper sulphate just as the buds are beginning to swell in the spring and before the leaves put out, and again with Bordeaux mixture just after the blossoms fall. Sometimes a third spraying is given later. All diseased leaves, fruit, twigs, etc., should be collected and burned. For the plum curculio, jarring, spraying with Paris green, and growing enough plums for both curculio and horticulturist are advised. At the Kansas Station the curculio was successfuly controlled by jarring the trees in the early morning and collecting the insects in the curculio catcher illustrated in fig. 5. "A sheet with the seam ripped half the length to permit its being readily placed around the tree is a cheap and effective substitute for the catcher here figured."

Picking and marketing.—For shipping, plums should be gathered as soon as they are well colored and some varieties even earlier. The 8-pound grape basket is a satisfactory package for local market purposes, but for shipment the 6-basket carrier is advised. Late plums usually bring the best prices.

METHODS OF GROWING ONIONS.

The Texas Station has made a study of the comparative economy of hand culture and horse culture and of bed and field planting of onions with the following results: "Hand culture with onions was more profitable than horse culture. Planting seeds in beds and transplanting to the field, with either hand or horse cultivated onions was more profitable than planting seeds in the field. It cost less (where labor ranged from 50 cents to 75 cents per day) to grow an acre of onions to maturity by planting the seeds in beds than by planting in the open field."

The financial results with two varieties tested were as follows:

Relative cost and profitableness of horse culture and hand culture of onions.

Variety and method of culture.	Yield per acre of salable onions.	Value of yield at 1 cent per pound.	Cost of growing crop to maturity.	Cost of gathering.	Cost of trimming and sacking.	Total cost of growing, trimming, and sacking crop.	Net profit per acre.
Red Bermuda onions:	*Pounds.*						
Horse culture, seed planted in field	4,551	$45.51	$16.65	$0.38	$3.80	$20.83	$24.68
Horse culture, seed planted in bed and transplanted to field	7,336	73.36	16.00	.61	6.10	22.71	50.65
Hand culture, seed planted in field	13,152	131.52	17.40	1.09	10.95	29.40	102.08
Creole onions:							
Horse culture, seed planted in field	7,842	77.42	16.65	.64	6.47	23.76	53.66
Horse culture, seed planted in bed and transplanted to field	8,257	82.57	16.00	.69	6.90	23.59	58.95
Hand culture, seed planted in field	10,664	106.64	17.40	.89	8.91	26.20	80.44

The method of culture recommended by the station on the basis of these results is in brief as follows: Varieties should be carefully chosen with reference to their adaptability to the section in which they are to be grown. The Red Bermuda and the Creole are recommended for South Texas. "Many of the most popular varieties grown farther north fail to produce a good crop in South Texas, and most of those that do make a satisfactory yield produce an onion that will not keep in this climate." The varieties which have done best at the Kansas Station, according to a recent bulletin, are Prizetaker, Yellow Danvers, Red Wethersfield, Silver King, and Giant Gibraltar. For planting in beds and transplanting to the field "about 500 square feet of bed surface is required for each pound of seed. This space can, by careful handling, be reduced to 400 square feet. Therefore, for an acre of transplanted onions to be cultivated in 30 by 4½-inch rows, 500 feet of bed surface will answer the purpose for each acre, and 1,000 square feet for onions transplanted in rows 14 by 4½ inches." By this method a saving of 33⅓ per cent seed over the amount required for field planting is effected.

A piece of rich sandy loam, free from weed seed and convenient to water, should be selected for seed beds. Seed may be sown in drills 3 or 4 inches apart, or broadcasted. In either case they should be covered with soil only one-half inch deep. If the weather is warm and dry the beds should be sprinkled twice a day until the seed germinate, which is usually about nine days. If moss or other similar material can be had it will be found of value to be used as a mulch on the seed beds until the plants are about ready to come through the ground. It should then be removed. The use of the mulch will reduce the number of waterings required and insure a larger percentage of germination. The seed beds should be kept free from weeds and the plants in a thrifty condition until they are about 6 inches high. They should then be transplanted to the field. * * *

Before transplanting, the roots and tops should be cut back. Besides benefiting the plants, this operation renders them more easily handled in the field while transplanting. If the soil to which they are to be transplanted is in proper condition, no trowel or dibble need be used, the onion being pressed into the ground by the forefinger. Cultivation should be shallow but frequent, never allowing the weeds a start. In cultivating, care should be exercised not to work the soil to the onions, or hill them. However, it is not necessary to remove the soil from the bulbs, as is frequently recommended.

Onions should not be gathered until they are fully matured, otherwise they will not keep. As they near maturity the tops break and lop down. After pulling they should remain in the field a few days until dry, and then the tops and roots should be trimmed off. They are then ready to be sacked and marketed, or removed to a suitable place and stored and held until marketed.

The New York State Station has recently made an interesting and valuable contribution to the subject of the fertilizing of onions. It was found that in certain market gardening regions, notably on Long Island, commercial fertilizers are frequently applied to onions at as high a rate as a ton of high-grade fertilizer per acre. The investigations of the station, while not conclusive as to the exact amount which

it is most profitable to apply, which of course varies largely with the conditions of soil, season, etc., show quite clearly that the present practice supplies an amount of plant food far in excess of the needs of the largest crop, and is therefore wasteful. "Considering the varying price of the marketable product, the close margin of profit from heavy manuring with fertilizers even with fairly good prices for the crop product, and the vicissitudes of the crop due to the limitations of season, the onion grower runs great risk of diminished profits when he uses 1,500 and 2,000 pounds of commercial manure per acre."

THE DIGESTIBILITY OF RAW, PASTEURIZED, AND COOKED MILK.

An interesting series of experiments to determine this very important question is reported by C. F. Doane and T. M. Price of the Maryland Station. Previous investigations on the subject have been quite limited and very discordant in results, although the idea generally prevails that any considerable heating of milk impairs its digestibility, however much it may otherwise increase its wholesomeness by destroying disease germs, etc. In the Maryland Station experiments calves not less than 6 weeks old were fed, in sufficient quantities to insure substantial growth, raw whole milk, raw skim milk, whole milk pasteurized at 167° F. for 10 minutes and 140° F. for 30 minutes, and whole milk cooked—i. e., heated to 185 to 190° F. for 30 minutes. While the milk in the latter case had not been boiled it had the appearance of boiled milk and possessed a decidedly cooked flavor. The following percentages of the protein and fat of the milk were digested in the different cases:

Digestibility (percentages digested) of protein and fat in milk differently treated.

	Protein.	Fat.
	Per cent.	*Per cent.*
Raw whole milk	94.79	96.82
	92.64	96.10
Skim milk (raw)	94.57	.....
Whole milk pasteurized at 167° F. for 10 minutes	92.99	94.27
Whole milk pasteurized at 140° F. for 30 minutes	92.01	96.61
Whole milk cooked (heated to 185–190° F. for 30 minutes)	87.26	95.40

The results indicate that raw whole milk is more completely digested than either pasteurized or cooked milk. The cooked milk, moreover, caused violent scouring in the majority of trials. Raw skim milk was apparently as digestible as whole raw milk. From the replies to inquiries addressed to physicians in charge of children's hospitals in the leading cities of the United States, it seems to be the consensus of opinion of such physicians that raw milk is to be preferred for infant feeding if it is known to be in perfect condition, but that under ordinary conditions pasteurized milk is safest. The use of cooked or sterilized milk is generally discouraged by physicians.

Another interesting fact brought out by these experiments is that milk is not entirely digested, although so stated to be by almost all authorities on such subjects.

Theoretically, perhaps, it is, as it contains none of the material which is recognized as the indigestible part of grains and fodders. In practical work, however, there is found to be a relatively large portion indigestible. In the work recorded in this bulletin the digestibility of the milk fed would average about 93 per cent with the protein and a little higher with the fat, some of the percentages being much lower than this in individual cases. It is likely that had a smaller portion of milk been fed a larger percentage would have been digested, and by reducing the amount to the minimum required to sustain life it is possible that practically all fed would have been utilized in the system. But where sufficient milk is fed to insure substantial growth, nearly one-tenth of the dry substance is undigested.

THE DAIRY COW AND THE WEATHER.

G. H. True, of the Arizona Station, has very recently published some observations which afford a striking illustration of the effect of exposure to storms upon the milk and butter production of dairy cows.

An experiment was undertaken to test the value of sugar beets as food for cows on pasture. The test was made with six cows and lasted from November 13 to December 11, 1900. It was planned to feed beets to cows Nos. 1, 2, and 3 during the first two weeks, and to cows Nos. 4, 5, and 6 during the last two weeks of this period. The experiment was somewhat interfered with by the refusal of cow No. 2 to eat beets, and also by a storm occurring November 17–19, to which the cows were exposed. The accompanying diagram shows (in pounds and tenths of a pound) the weekly variations in the production of butter fat by each cow during the experiment, thus cow No. 2 produced 4.4 pounds of butter during the week ended November 20, and 3.65 pounds during the week ended November 27.

The results of the experiment are taken by Mr. True as the basis of a discussion, which is substantially as follows:

The relation of the comfort of the cow to the cash received by her owner for her products is one that every dairyman should study with much interest. Enough good food and pure water, shelter from the heat of summer and storms of winter, and kind treatment are just the conditions man demands for his own comfort and just what would be due every animal from every owner, for humanity's sake, even were there no business relations between them.

The body of the cow, which is a complicated piece of mechanism, is so constructed as to do its work best at a temperature of about 101° F. Any marked deviation from the normal temperature indicates an abnormal or diseased condition of the body. This temperature is maintained by the generation of heat within the body itself, independent of outside conditions, but in accordance with their demands, one use of the food eaten being that of fuel to be burned in keeping the body warm. Not only must the body be warm enough, but it must not be too warm. So, when the air is warmer than the body itself, moisture is brought to the surface and the evaporation of this has the necessary cooling effect. Then, again, the body must be kept dry, and, just as fuel is necessary for production of steam in the boiler, so is fuel necessary in the body of the cow for the evaporation of snow or rain from her back and sides.

Prof. F. H. King, in his Physics of Agriculture, is authority for the statement that "if a cow evaporates from her body 4 pounds of water she must expend the equivalent of 3.39 pounds of milk solids" in so doing.

When we stop to think it over, therefore, we come to the conclusion that the food of the cow serves some very important uses in her body aside from being converted

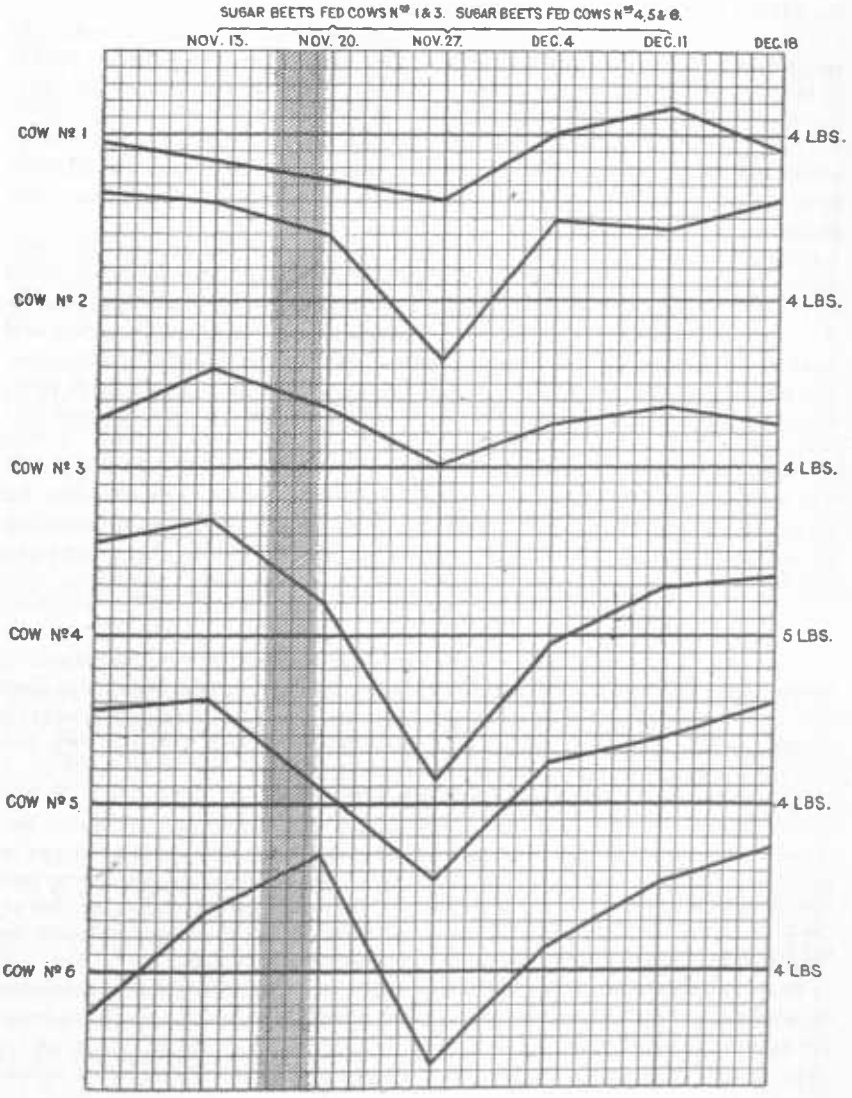

FIG. 6.—Diagram showing the effect of a storm, November 17–19, 1900, on the butter-fat production of different cows.

into the product we desire for market; machinery must be kept going, the waste repaired, and the temperature maintained. In following out the familiar law of self-preservation, which is said to be the first law of nature, these functions are performed first, and, if need be, at the expense even of that product intended for the nurture of offspring. If, then, a profitable flow of milk is to be maintained, not only must food

be supplied for its manufacture, but for those other necessities of the body, which vary to meet the demands imposed by outside conditions. These are facts familiar probably to every reader, and yet how few realize their practical bearing on their own work.

The keeping of a herd record has enabled us to observe some of the practical bearings of the case, and below will be given very briefly some observations bearing on the relation of cold and rain to milk and butter fat productions.

A study of the record of the amount of milk delivered at the creameries during the year seems to point to the fact that summer rains tend rather to increase the amount of milk brought to the creamery than otherwise. This increase is probably due to the cans being left open and not to an increased flow from the herds. In the case of our own herd there has been a falling off in the amount of milk due to heavy rains, amounting to 10 per cent. The cows have recovered quickly from this decrease, however, and when the rains have been light no detrimental results have been noted.

During the second week of December, 1901, Salt River Valley experienced something of a cold wave, which is to say the average temperature for twenty-four hours dropped 17° F. in two days, and a minimum temperature of 24° was registered by the weather bureau. There are few localities where this would be called cold weather, but compared with the warm weather preceding and following it was cold. The creamery record seemed to show nothing more than a normal falling off in the amount of milk delivered during this time. The six cows of the station herd were upon rather poor pasture, but three of them were receiving hay in addition. During the week including the cold weather the three cows on pasture alone gave 10 pounds less milk and one-half pound less butter fat than the preceding week, while the three cows having hay gave 20 pounds less milk and 1½ pounds more butter fat. From this it would appear that there was no falling off in product due to the cooler weather, but that the decrease from the cows on pasture alone was normal, while with those having hay the cold weather acted as a stimulant, causing a temporary rise in amount of product.

In the case of winter rains there seems to be no questioning their bad effect. A single example: The 17th, 18th, and 19th days of November, 1900, were rainy days. From the day before to the day after the rains the amount of milk delivered at the creameries fell off 10 per cent. In the same time the milk from our own herd decreased 37 per cent and continued to decrease until it had reached 50 per cent. It then took the cows a month to get back where they were before the rain.

The week of the storm and that following, two of the six cows had sugar beets in addition to their pasture. During these two weeks the four cows having pasture alone fell off 46 per cent in amount of butter fat given, while the two having beets fell off only 20 per cent. Here is to be noted not only the effect of storm, but the effect of feed as well, the cows having sugar beets during the storm falling off less than half as much in their butter fat as did those on pasture alone.

From these observations we may safely conclude: That the exposure of dairy cows to winter rains results in serious loss to the dairyman; that this loss may be decreased by abundant feed; that the dry cold of our winter days calls for additional feed for the cows; and that exposure to the heavier summer rains should be guarded against.

In a recent report of the Indiana Station, A. W. Bitting calls attention to the fact that in experiments made at that station in 1893, "milch cows exposed to the weather in the winter, but provided with night shelter, made a very unfavorable showing, as compared with those given shelter in the stable, excepting for brief airing when the weather was suitable. The exposed cows ate more food, lost in weight and

also in milk yield, while the sheltered ones gained in weight and made a better showing. At the Kansas Experiment Station similar results were obtained."

FEED MILLS AND WINDMILLS.

Professor King, of the Wisconsin Station, has made a study of the effectiveness of various feed mills found on the market, when driven by windmills and gas engines, and of the cost of grinding feed. With one of the most effective combinations of windmill and feed mill the rate of grinding was "about 25 bushels per hour with a wind velocity of 31.8 miles, the meal being a little coarser than 'medium.' Corn and oats were ground at the rate of 410.3 pounds per hour with the wind at 26.48 miles. With a wind velocity of 26.67 miles oats were ground at the rate of about 5.5 bushels per hour, and rye at the rate of 15.35 bushels with the wind 25.35 miles. The rye was ground a little finer than 'medium' and the oats a little coarser."

Under Wisconsin conditions there are on the average from October 1 to May 1 of each year "87 days when a man could attend the mill and grind 10 hours with a wind velocity not less than 15 miles per hour, and much of the time higher than this. He should therefore be able to grind more than 46 bushels per day and on the average more than 100 bushels per week. The 87 grinding days during the 7 months places the grinding days, on the average, more than 2 per week, and if it is supposed that this is twice too high it would still be possible on the average to take advantage of high winds during the working hours and grind about 50 bushels of corn, or 2,800 pounds, per week. Counting the man's time who tends the mill $1 per day, the cost of grinding would be only about 3½ cents per hundredweight."

When gas engines were used as the motive power "the average amount of corn ground per horsepower per hour was 4.822 bushels, equal to 270 pounds," at a cost of about 1.3 cents per hundredweight for fuel, with gas costing $1.25 per 1,000 feet.

It is estimated that at the rates ordinarily paid the grinding of feed for 30 cows for 200 days amounts to about $57; the same amount of feed may be ground with a 5-horsepower engine, under the conditions obtaining in these trials, for about $13.50. Fifty-seven dollars "is 10 per cent interest on a much larger sum than would be required to fit up an automatic grinding plant with the 12-foot windmill, the price of the mill and 90-foot tower being $160, and the capacity of such a grinding plant would be many times what would be demanded for a herd of 30 cows."

FARMERS' BULLETINS.

The following is a list of the Farmers' Bulletins available for distribution, showing the number, title, and size in pages of each. Copies will be sent to any address on application to Senators, Representatives, and Delegates in Congress, or to the Secretary of Agriculture, Washington, D. C. The missing numbers have been discontinued, being superseded by later bulletins:

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